United States Department of Agriculture
Forest Service
Pacific Northwest Region
319 S. W. Pine
P. O. Box 3623
Portland, Oregon 97208

Reply to: 1990 Special Plans and Studies
3420 Detection

Date: April 10, 1981

Subject: Mt. St. Helens Pest Damage Potential

To: Eugene E. Smith
Through Forest Supervisor, Gifford Pinchot NF

In response to the request for information from the Sierra Club, a copy of "Potential for Forest Insect and Disease Losses in the Mount St. Helens Area" is enclosed. It lists the specific insects and diseases that may cause problems in the Mt. St. Helens area, pertinent information on their biology as it relates to potential damage or degrade, and a procedure for determining relative priorities for harvest in damaged stands. Also enclosed is "Forest Insect Conditions in the Volcanic Area of Mt. St. Helens" dated August 26, 1980. These two articles were used to complete the Draft EIS and the Timber Salvage EAR. In addition, we have included a letter to the record dated August 18, 1980 on the status of insects at four locations on August 1, 1980.

We expect that most of the potential insect activity will be around the edges of the damage area where green trees are adjacent to damaged trees. At this time we do not have specific locations we can point to on a map where pest problems may develop. Locations of potential pest problems will be determined by the timber types present rather than physical site conditions. It is possible for a pest such as Douglas-fir beetle to increase to damaging levels anywhere in the area where Douglas-fir exists unless preventative steps are taken to reduce this threat.

Washington State Department of Natural Resources, Weyerhaeuser Company, and The University of Washington College of Forest Resources have established monitoring plots in three separate areas.

Washington State Department of Natural Resources plots are located in the North and South Forks of the Toutle River. They have found little insect activity yet. However, some ambrosia beetle was evident in blowdown. There is very little deterioration now, but by next year deterioration of smaller material is expected.

Weyerhaeuser plots are in the Green River drainage. They have noted an increase in ambrosia beetle activity and about 40 percent of their plots show some Scolytid or Buprestid activity. Since most of their plots contain true fir and hemlock and the stands are of a younger age class than most of the stands managed by the Forest Service, the species of insects attacking them may be different from other areas.

University of Washington plots are near Ryan Lake and in the Clearwater Drainage. Douglas-fir beetle attacks are light, but vigorous. They expect that in down material close to the perimeter, beetle populations may cause damage to standing green trees in the next year or two.

The Forest Pest Management Staff of the Forest Service plans to monitor insects and diseases in the damaged and surrounding area for at least the next 5 years. To date Forest Pest Management has not established any permanent, long-term, monitoring plots, preferring instead to spot check a large number of sites throughout the area damaged by the volcanic eruption. In the spring and summer of 1981, pathologists and entomologists will be sampling trees along the edges of the damage for decay organisms and insects, especially, beetles. This sampling will be done after the peak attack periods for insects such as Douglas-fir bark beetles and ambrosia beetles.

We need to emphasize that there was very little insect activity in 1980 because the insect populations appeared to be decimated in the damaged areas. Insect populations outside the damaged areas will probably not begin to increase significantly until the 1981 season. Populations increasing in 1981 will not emerge until 1982. With the exception of ambrosia beetles, 1982 is the earliest we expect to observe increased attacks in the fringe areas. Wood deterioration is directly tied to insect activity so it should be 1982 before degrade starts to appreciably increase.

In addition to this monitoring, the USDA Forest Service Pacific Northwest Experiment Station has studies outside the general damage area to assess the effects of ash on defoliating insect populations.

James S Hadfield

JAMES S. HADFIELD, Acting Director
Forest Pest Management

Enclosures

cc: Boyd Wickman, PNW
✓Bruce Hostetler

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Region 6
P. O. Box 3623, Portland, Oregon 97208

REPLY TO: 1990 Special Plans and Studies

August 26, 1980

SUBJECT: Forest Insect Conditions in the Volcanic Area of Mt. St. Helens

TO: Eugene Sloniker
Through District Ranger, Mt. St. Helens RD

Enclosed find a copy of the brief requested on the insect situation in the Mt. St. Helens area.

ROGER E. SANDQUIST
for DAVID McCOMB, Entomologist
Forest Insect and Disease Management

Enclosure

DMcComb:mw

cc: Sandquist
McComb

KEY

COPY FILE COPY

D. McComb
August 26, 1980

Forest Insect Conditions in the Volcanic Area of Mt. St. Helens

Douglas-fir beetle *Dendroctonous pseudotsugae* (Hopk.) is the most destructive insect enemy of Douglas-fir forests in the Pacific Northwest. This small beetle is present in Douglas-fir forests at all times and annually kills scattered and small groups of trees. In the past, beetle epidemics have developed as beetle populations increased in storm-damaged trees. However, those infestations usually collapsed in 1 or 2 years after populations moved into healthy green timber.

Although there has been no previous experience with the action of the beetle in volcanic-damaged timber, it is possible to make some educated predictions as to what may occur.

Fortunately, beetle activity has been light in this area in the past several years. This may provide more lead time to salvage the downed timber before beetle populations increase.

A limited number of observations have been made in the damaged area. During these observations, only a few isolated bark beetle attacks were observed, mainly in the outer edge of the affected area. None were found in the area where all trees were down and heavily ash covered. Further surveys are planned in marginal areas where many damaged trees are still standing with varying degrees of foliage damage.

Based on our observations, there is a strong possibility over the next 2-3 years, commencing with the beetle flight of 1981, populations will build up within the dead and damaged trees. During the summer of 1983, but more likely in 1984, beetles emerging from the unsalvaged trees will attack standing healthy trees surrounding the volcanic damaged area.

The more infested material that is removed from the blast area before the spring of 1984, the fewer beetles will be present to attack healthy green trees. Whenever possible, control operations, such as timber salvage and slash disposal, should be intensified in all areas except the core area where the blowdown was complete and the down trees were heavily covered with ash.

Two species of bark beetles, collectively called silver fir beetles, are destructive to true fir forests in western Washington. *Pseudohylesinus granulatus* (Lec.) the fir root bark beetle and *P. grandis* (Sw.), the silver fir beetle characteristically attack windthrown, felled, and injured trees. An outbreak in 1954-55 killed 528 million board feet in Washington before the outbreak subsided, primarily due to natural control.

The remarks made previously in regard to the potential for a Douglas-fir beetle outbreak also applies to the silver fir beetle with the exception that since the silver fir beetle has a 2-year life cycle, a major outbreak in volcanic-damaged timber might be slower in developing.

PEB

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Region 6
P.O. Box 3623, Portland, Oregon 97208

REPLY TO: 1990 Special Plans and Studies
3420 Detection

August 18, 1980

SUBJECT: Potential for Forest Insect Outbreaks in the Mount St. Helens Area

TO: Record

On Friday, August 1, Dave Bridgwater and Tom Gregg were accompanied by Rick Johnsey, Washington Department of Natural Resources, and Dr. Bob Gara, University of Washington, on a low-level helicopter survey of the Mount St. Helens damage area. The purpose of the trip was to make a preliminary evaluation of the potential for forest insect outbreaks in the damaged timber. We were also interested in determining if a low-level helicopter sketchmap survey was needed to supplement the data recorded on the timber layer of the U-2 photo interpretation project completed in late July.

Four sites were visited on the ground. These sites are marked on the attached map and are described as follows:

AREA-1 - located 4 miles west of Mount St. Helens along the South Fork of the Toutle River at the 950-ft. elevation. The stand consists of both standing dead and downed large sawtimber. The area was adjacent to a large area of undamaged green timber. The site was occupied primarily by true fir and Douglas-fir.

AREA-2 - located 11 miles west northwest of Mount St. Helens on the North Fork Toutle River in the 1,000-ft. elevation zone. The area examined contained a small sawtimber size mixed-conifer stand consisting of standing dead trees. Species composition was primarily western redcedar, true fir, and Douglas-fir.

AREA-3 - located 15 miles northwest of Mount St. Helens on the Green River. The site was occupied by large sawtimber consisting primarily of Douglas-fir and true fir that had been completely uprooted by the May 18 eruption. The area was about 1 mile south of adjacent green stands.

AREA-4 - located 12 miles northeast of Mount St. Helens. The stands contained true fir and mountain hemlock of mixed-size classes. The band of standing dead common in other areas was very normal to almost non-existing. In a few areas, the down timber is adjacent to the green trees. Many of the crowns that had been exposed to the heat were only partially damaged. Buds on some of the noble fir have opened with new foliage. A few of the saplings that were pushed over and covered by the thick layer of ash have pushed up through the ash.

Although Douglas-fir beetle and ambrosia beetle attacks were the most prevalent, and fresh attacks were found at every site containing downed Douglas-fir, attacks were scattered and difficult to find, as anticipated, since the population in the Mount St. Helens area has been very low for several years. The amount of material available to the limited number of insects is enormous.

At site 1 all the attacks appeared to be successful; in fact, the adults had emerged to make second attacks.

On the Green River, however, many of the Douglas-fir beetle broods were unsuccessful because of the large amount of moisture in the logs. Since the trees are unable to transpire, the suitability of the phloem for Douglas-fir beetle brood development is unsuitable at this time.

No fir engraver beetles, silver fir beetles, roundheaded, or flathead woodborers were observed. One roundheaded woodborer adult was observed in flight.

During the short time spent on the ground, we were unable to find evidence of ant populations or other ground-inhabiting insects.

Spiders, on the other hand, appear to be relatively common, especially in the areas adjacent to green stands. They appeared to be foraging for food.

A supplementary FIDM low-level helicopter aerial survey appears unnecessary at this time. The down and damaged standing stands are visible in aerial photos. There is no evidence of broken tops, broken limbs, or other damage in the adjacent green stands.

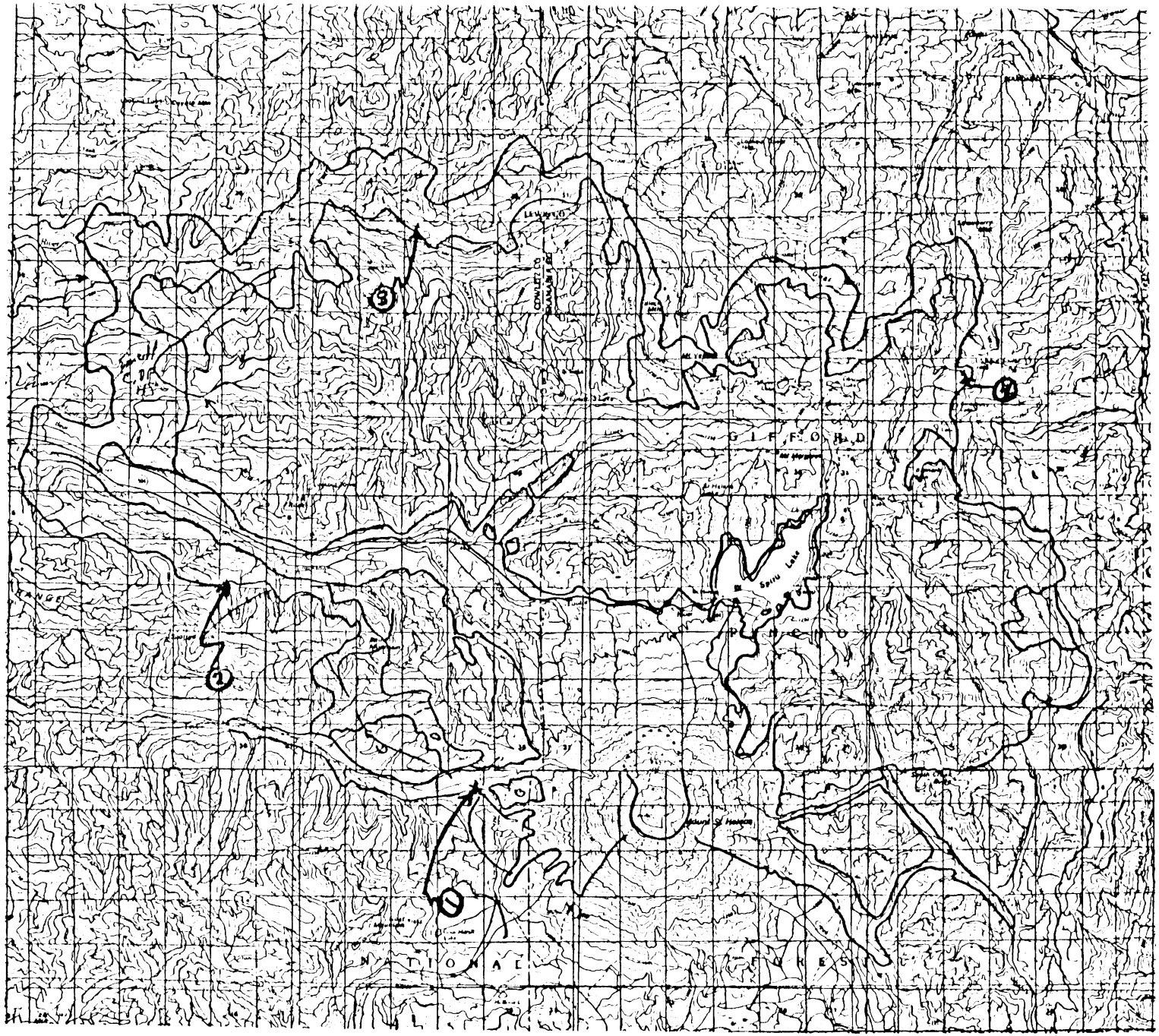
Aerial surveys will be needed in '81 and '82 if populations of Douglas-fir beetle and silver fir beetle build and move into adjacent green stands.

Tommy F. Gregg

TOMMY F. GREGG, Forestry Technician
Forest Insect and Disease Management

cc: Dave McComb, FIDM
Arvid Ellson, Mt. St. Helens Recovery Team
FS, Gifford Pinchot NF
Dr. Bob Gara, U. of W.
Rick Johnsey, WDNR
Boyd Wickman, PNW, Corvalli.

PEB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POTENTIAL FOR FOREST INSECT AND DISEASE LOSSES IN THE MOUNT ST. HELENS DAMAGE AREA

Introduction

In assessing the potential for forest insect and disease problems in the green stands around the Mount St. Helens damage area, entomologists and pathologists visited several sites looking for evidence of insect activity and wood staining and decaying fungi. Stands containing both blowdown and standing dead and green trees were checked. Of special interest were the damaged areas immediately adjacent to green timber since bark beetles and other woodboring insects are expected to move into the damaged trees from surrounding areas.

A wide variety of stand conditions existed at the sites visited, specifically stand composition, age, density, and tree size. Information about these factors is necessary in assessing the potential for insect and disease problems in the near future.

Maps showing the extent of damage from the May 18th eruption were available on the timber layer prepared during the U-2 photo interpretation project completed in late July.

Detailed pre-eruption data for specific stands on National Forest lands were available in the TRI System files at Fort Collins Computer Center. Maps with compartment and stand boundaries are available on microfilm files.

Comparable scale maps were prepared and the selected damage categories overlaid with the TRI compartment timber cell maps. The stand identification numbers were recorded for stands partially or wholly within the designated damage areas.

Stand profiles were then extracted from the TRI System and listed for review and consideration in making insect hazard projections. These data, along with observations made on the ground, revealed a variety of timber types and age classes. Predominant timber species include Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, western hemlock, *Tsuga heterophylla* (Raf.) Sarg., Pacific silver fir, *Abies amabilis* (Loud.) Forbes, noble fir, *Abies procera* Rehd., and mountain hemlock, *Tsuga mertensiana* (Borg.) Car. All size classes are present within the volcanic area.

We have no data on volcanic areas describing the impact that forest insects and diseases have on reducing the value of the damaged timber or on the potential for forest insect and pathogen populations developing within damaged trees and spreading into the surrounding healthy timber.

However, there are data available on the effects of insects and diseases in blowdown timber, fire-damaged stands, trees defoliated by insects, and flood areas in similar type forest stands in Oregon and Washington. While such conditions are not precisely the same as those in the volcanic area, many assumptions may be made based on these data.

Potential for Insect Damage

Douglas-fir beetles - This bark beetle, *Dendroctonus pseudotsugae* Hopk., is the most destructive insect enemy of Douglas-fir forests in the Pacific Northwest. In the past (3, 4, 5, 6, 7), beetle epidemics have developed in storm-damaged, burned, or severely defoliated stands.

A report of the Timber Disaster Committee (8) to the annual meeting of the Northwest Forest Pest Action Council on October 23, 1964, two years after the Columbus Day Storm, reported that although 60 percent of the concentrated blowdown of 12.8 billion board feet had been salvaged, it was estimated that 500 million board feet of standing healthy green trees had been infested by beetles emerging from the blowdown.

The eruption on May 18 occurred at the height of the 1980 Douglas-fir beetle flight period, and this may have had a negative effect on the beetle population in that area. Fortunately, beetle activity has been light in this area in the past several years. This may provide more lead time before the beetle population develops to outbreak proportions.

In the damaged area, the beetles should continue to attack and develop large broods in injured and damaged trees throughout the summers of 1981 and 1982. Following that period, the beetles will fly into surrounding green stands and attack healthy trees. Infestations in green stands have a history of collapsing after 1 or 2 years. Unfortunately, a large volume or number of trees may be killed during this short period because of the enormous populations.

The more infested timber that is removed from the damaged area before the flight periods during the springs of 1983 and 1984, the fewer beetles will be present to attack healthy green trees. Wherever possible, control operations, such as timber salvage and slash disposal, should be intensified except for the core area where blowdown was complete and the down trees heavily covered with ash. To date, no beetle activity has been observed in this, the most severely damaged area, although beetle attacks have been observed in the lesser damaged areas.

Silver fir beetles - Two species of bark beetles, collectively called silver fir beetles, are destructive to true fir forests in western Washington, *Pseudohylesinus granulatus* (Lec.), the fir root bark beetle, and *P. grandis* (Sw.), the silver fir beetle, characteristically attack windthrown, felled, and injured trees. An outbreak in 1954-55 killed 528 million board feet in Washington before the outbreak subsided, primarily due to natural control (9).

Damage to green stands has been observed only in mature to overmature timber. Since these beetles are widely dispersed in green stands, the common method of controlling bark beetles by treating infested trees is ineffective. Prompt salvage of infested, damaged and down timber offers some control benefits. Since these beetles have a 2-year life cycle, a major outbreak in volcano-damaged true firs will be slower in developing than the Douglas-fir beetle.

Ambrosia beetles - Several species of small beetles that construct their galleries in the sapwood of unseasoned or moist wood are collectively known as ambrosia beetles. These beetles attack weakened, recently dead, and freshly killed trees, and a heavy invasion by these beetles may reduce the market value of damaged timber as much as 50 percent (2).

Large amounts of timber were windthrown in western Washington in the fall of 1958. Surveys in this blowdown, including the Mount St. Helens area (3), concluded that two species of ambrosia beetles caused significant damage to down trees. One species, *Gnathotrichus sulcatus*, (LeConte), showed a preference for old-growth trees. The other, *Trypodendron lineatum*, (Olivier), showed no age class preference but was significantly more abundant in shaded blowdown than exposed.

Studies by Kimmey and Furniss (4) of fire-killed and damaged Douglas-fir reported that ambrosia beetles are frequently the first insects to attack burned trees and are the only sapwood-infesting insects causing appreciable deterioration.

Ambrosia beetles were observed in both blowdown and flood-damaged timber in the Mount St. Helens area during August 1980.

Due to the large number of trees with varying degrees of injury in the damage area, ambrosia beetle attacks are expected to continue and increase throughout the spring and summers of 1981 and 1982. These attacks will cause a loss in value of timber which has been damaged but will pose no threat to surrounding healthy green trees.

Wood borers - Insects which show a potential for impacts are the metallic or flatheaded borers, family *Buprestiodae*, longhorned or roundheaded borers, family *Cerambycidae*, and the horntails, family *Siricidae*. Although these three families are not closely related, their habits and damage are generally similar.

All are primarily pests of injured, weakened, and recently dead trees. Most damage occurs in the sapwood. Most insects require 2 or more years for development of a generation. They are not expected to move from injured and damaged timber to become a problem in standing, healthy trees.

Most damage will occur before the timber is removed from the site. Once timber is processed, only rarely will reinfestation of the finished product occur. However, once these insects are within the wood, they will continue to develop in green and improperly treated wood only to emerge months or even years after the wood product has been in use. However, kilndrying kills all stages of the insects in the wood and is recommended for all lumber products made from the volcano-damaged timber that has been infested by wood boring insects.

In reality, little volume losses will result from attacks by these insects. Product degrade and customer complaints may overshadow volume losses.

Control of these insects is best accomplished by prompt removal of damaged logs from the woods. Most down material will remain attractive to these pests for several years. Each additional year the product is left in the forest allows extra time for more attacks and extension of galleries deeper into the heartwood. Preventative treatment of standing, undamaged timber is not recommended or needed.

Flatheaded borers - Larvae of this family make oval-shaped holes in the sapwood and occasionally bore deep into the heartwood. Of the many genera of *Buprestoidea* in the Mount St. Helens area, the *Buprestis* will be the most

common. The golden buprestid is the most notorious of this group. The golden buprestid can utilize wood within a wide range of moisture content. This insect has been known to remain alive in sawn lumber for as long as 20 or 30 years before emerging from the product long after it has been in use. This is one of the few wood borers that will occasionally reattack untreated wood surfaces to continue the attack and destruction of the wood.

Those flatheaded borers of the genus *Melanophila* will also be common in the damaged timber areas. These insects, however, limit their attacks to the cambium area and only lightly score the sapwood. Their populations are expected to build but they will not later move to attack standing, undamaged trees.

Roundheaded borers - Larvae of this group also concentrate their boring in the sapwood with occasional borings into the heartwood. They generally are not as numerous as the flatheaded borers, but often their boring holes are much larger and more destructive. Life cycles of roundheaded borers generally are shorter than those of flatheads. Reinfestation of wood after adult emergence will not occur. Most common of these are the sawyer beetles of the genus *Monochamus*.

Horntails - Adults of this wasp are usually a dark metallic color with yellow markings on the abdomen. A hornlike ovipositor, which resembles a stinger, is located at the rear of the abdomen. The larvae are cylindrical, with a spine at the end of the abdomen and up to 1½ inches long. As they feed throughout the wood, they make perfectly rounded holes. These insects are not as common as the flathead and roundheaded borers, but their feeding galleries often penetrate deep into the heartwood. They will not reinfest material from which they emerge nor will they infest wood from which bark has been removed.

Reforestation insects - Without any previous experience in reforesting a volcanic blast area, it is difficult to predict the insect problems that may develop. All green plant life on large areas was either killed or ash covered. Trees planted in these areas may provide the only available food for a variety of insects surviving in or moving into the blast area. Reports have been received of a weevil, *Steremnius carinatus* (Mannerheim), which normally feeds on a wide variety of plant material, girdling true fir seedlings recently planted on a test plot in the ash covered areas.

Decay Potential

To assess the decay potential, several assumptions have to be made which may or may not be valid. The damage is similar to fire damage or severe defoliation and can be treated as such. The obvious differences are that of heat, both in temperature and duration, and in much of the blast area, the blowdown condition. Another assumption concerns the insect activity over the next several years. Following fire, the populations of various timber attacking insects greatly increase (4, 11, 12). These include species of bark beetles, wood borers, and ambrosia beetles; (especially *T. lineatum* and *G. sulcatus*). This population increase is largely due to the sudden increase in susceptible host material.

There is a very close relationship between insect and fungal activity. Insects are often the primary means of spread for decay organisms, serving as vectors (10, 11). Also, insect boring holes provide early access for fungal organisms to wood tissues (12). Therefore, the deterioration rate from wood decay fungi is directly related to insect activity.

There is a large amount of insect host material in the Mount St. Helens area. The level of increase in insect population will be dependent on other factors. The most important of these is probably the effect of the volcanic ash on the adult insects.

Fire-killed timber is usually quickly colonized by decay fungi following insect attack. The Douglas-fir bark beetle (*Dendroctonus pseudotsugae*) has been shown to be the major vector of *Cryptoporus (Polyporus) volvatus* (Pk.) Hubbard and *Fomitopsis (Fomes) pinicola* (Schwartz ex Fr.) Karst (10). Stands of fire-killed Douglas-fir usually show a high rate of Douglas-fir beetle colonization within 1 or 2 years. As expected, *F. pinicola* is a common cause of deterioration in this host (4, 10, 11). The pattern of rapid colonization by decay fungi following insect attack has also been reported in true firs (*Abies* sp.) (11) and western hemlock.

Several fungi are commonly found decaying timber within 2-5 years of death by fire in the Pacific Northwest. The most common fungus, *F. pinicola*, is found on most conifer species. In fire-killed Douglas-fir, this organism was found to cause 59 percent of the total deterioration observed. It causes a brown cubical rot of the sapwood, then heartwood. The second most common decay fungus is *Polyporus abietinus*. It caused 30 percent of the decay in fire-killed Douglas-fir (4). Other decay fungi have been found to a lesser extent. These include: *Lenzites saepiaria* (Wulf.) Fr., *Cryptoporus (Polyporus) volvatus* Pk., and *Ganoderma (Fomes) applanatus* (Pers.) Gill., which is more common on hemlock and true firs than on Douglas-fir. Sapwood stain is also frequently observed.

The rate of deterioration in timber is dependent upon the proportion of sapwood to heartwood. Small, young timber has a higher proportion of sapwood than large, old-growth timber. Sapwood is usually attacked first, and within 2 years after fire or beetle attack, the sapwood is no longer suitable for products other than pulp (4, 12, 13). For this reason, timber in stands of the younger age classes is in more danger of deterioration beyond merchantability than older age classes. In Douglas-fir, typically the heartwood begins

to deteriorate the fourth year following fungal colonization of the tree. By the sixth year, from 25 percent to 50 percent of the tree volume will be lost, depending upon factors including size and age (13).

In addition, fungal colonization and decay rates are dependent upon the moisture content of the wood. Generally, sapwood deterioration will be reduced in wood that is too wet (11). The moisture content of sapwood is dependent upon numerous factors. Those most important include foliage relations (11), tree positions, and site. Generally, standing timber with some needle retention can be expected to have reduced sapwood moisture and faster fungal colonization and decay than down timber with no foliage retention.

Deterioration rate is also dependent upon tree species. Cedar is usually not subject to rapid deterioration and can be expected to remain undeteriorated for longer periods than other species. Wind-thrown and fire-killed mountain hemlock, western hemlock (12), and true firs (11) have typically displayed a faster rate of decay than Douglas-fir following insect attack.

DETERMINING THE RELATIVE PRIORITY FOR HARVEST IN DAMAGED STANDS

A procedure has been established to help set harvest priorities for damaged stands in the Mount St. Helens damage area. The procedure ties together, in a relative way, important factors relating to the development of major forest insects and wood-decaying fungi discussed above. It is recommended that the potential for insect and disease damage be considered in establishing salvage priorities. These procedures will reduce the likelihood of future losses in adjacent green stands and minimize deterioration from wood decays and wood-boring insects.

The numerical values found in Tables 1-3 are not based on quantitative research data, but are subjective values agreed upon by forest entomologists and pathologists after numerous trips into the damaged area. The values reflect the relative importance of specific data available in the TRI data base and on the timber layer of the U-2 photo interpretation project.

When setting priorities, the user should be aware of one major concern that entomologists and pathologists have about the damaged timber. The down trees have unusually high moisture in the phloem, and the consequences of this waterlogged condition to insects and diseases is that the phloem may sour or otherwise become unsuitable before drying enough to allow for colonization by many insects and/or disease organisms. If this occurs, we do not anticipate high populations of bark beetles or rapid deterioration of wood from the major wood decaying fungi.

Unlike normal winter blowdown where trees tend to transpire and dry throughout the spring when the insect is in flight, normal drying through transpiration is not expected to occur near Mount St. Helens since practically all damaged trees have no foliage to draw moisture from the trees.

In standing trees, we see the similarity, in many respects, to conditions found when trees are severely defoliated by insects or the foliage has been destroyed by fire. Transpiration is reduced or stopped and the bole often becomes waterlogged. This condition is normally most prevalent in the lower bole where moisture is concentrated. Bark beetle survival may be near normal in the upper bole where conditions are drier.

The relative harvest priority as described here is a function of species, size class, relative abundance of major or minor species, relative proximity of stands, and the condition of damaged trees after the May 18 eruption.

Priorities for reducing the threat of future bark beetle losses in adjacent stands can be found by entering Table 1A with the stand description extracted from TRI. Two values should be selected, one for major species and one for minor species. In stands of pure type where no minor species occur, the minor species value for the major species should also be selected.

Table 2 describes the relative importance of location of damaged timber to healthy stands. When stands of similar type are adjacent to each other, the emerging Douglas-fir beetles and silver fir beetles will have little trouble moving from damaged trees into the green trees. When the distance of travel (for the beetles) increases, the rate of insect mortality during dispersal also increases.

Damaged stands were classified into three damage categories on the timber layer of the U-2 photo interpretation project. The relative importance of bare ground, down trees, and standing dead are available in Table 3.

The likelihood of the Douglas-fir or the silver fir beetle infestation building in green stands adjacent to damaged stands can be determined by summing the values from Table 1A and Table 2, then multiplying this product by the value in Table 3. Table 1B can be used to determine the relative potential for wood deterioration from woodboring insects and fungi in dead trees.

When using these results, the ranking by priority is in a descending order, i.e., a higher accumulated value indicates a higher priority for removal.

For example, a standing dead stand of small sawtimber with Douglas-fir and true fir as the major and minor species, respectively, that is adjacent to a stand of similar type has two harvest priorities to consider. The first is the relative potential for bark beetles moving into adjacent green stands in 1983 and 1984, $(3 + 1 + 4) \times 1.5 = 12$. The second is the relative potential for wood deterioration in the damaged trees, $(3 + 3 + 4) \times 1.5 = 15$.

Table 1A.--Relative potential for bark beetle populations moving into adjacent stand of the similar type and composition in the Mount St. Helens damage area.

Tree species	Abundance of tree species	Size class	
		Large sawtimber	Small sawtimber
Douglas-fir	Major	5	3
	Minor	3	1
True fir	Major	3	2
	Minor	3	1
Hemlock spp.	Major	.5	.5
	Minor	.5	.5
Cedar	Major	.5	.5
	Minor	.5	.5

Table 1B.--Relative potential for woodboring insects and fungal organisms to cause wood deterioration in damaged timber in the Mount St. Helens damage area.

Tree species	Relative abundance in stand	Size class	
		Large sawtimber	Small sawtimber
Douglas-fir	Major	1	3
	Minor	.5	2
True fir	Major	3	5
	Minor	1	3
Hemlock spp.	Major	2	4
	Minor	.5	2
Cedar	Major	.5	.5
	Minor	.5	.5

Table 2.--Importance of location of healthy and damaged stands in estimating the potential for insect and disease problems in the Mount St. Helens damage area.

Species	Location	
Major spp.	Damaged area adjacent to green stand	Damaged area not adjacent to green stand
Douglas-fir	4	1
True fir	3	1
Hemlock (others)	1	.5

Table 3.--Relative importance of damage categories in estimating potential of insect and disease problems in the Mount St. Helens damage area.

Insect and disease factor	Bare ground - destroyed timber (bark removed)	Down trees (bark attached)	Standing Dead (bark attached)
Major bark beetles	.5	1	1.5
Diseases and wood-boring insects	.5	1	1.5

Summary

With the exception of the heavy ash cover, damage to the forests was essentially the same as that due to fire, flood, defoliators, and wind-throw. Based on our knowledge of what has happened in the past in damaged timber of this type, there is the possibility that large populations of insects will develop in timber that is not promptly salvaged. Some species of insects will emerge from the damaged area to invade and kill healthy green trees in the surrounding area. A large volume of green timber could be killed unless down material is promptly salvaged. The losses in green stands will probably occur during 1983 and 1984 and should be short lived.

The initial colonization by decay fungi in dead and down timber has already started to occur at a low level within the damaged zone. This is due to the low insect population. The insect population can be expected to increase in 1981 and 1982. Decay of dead timber will start to accelerate along with insect colonization of this material. The expected occurrence, level, and pattern of decay is as follows:

1. Standing Vs. Blowdown

Dead standing timber is expected to incur fungal deterioration first and at a somewhat faster rate than downed timber.

2. Timber Species

Hemlock and true fir will suffer a faster decay rate than Douglas-fir once the deterioration process has begun. After 1 year of decay, 10 to 20 percent of the gross board-foot volume will be cull. After the second year of decay, up to 50-100 percent of this volume will be cull (4, 11). Douglas-fir sapwood will decay completely within 2-3 years. The heartwood of Douglas-fir is more resistant to decay than hemlock or true fir with cull level and salvageability being dependent upon size class.

3. Size Class

The percent cull which occurs over time is largely dependent upon the proportion of sapwood to the more decay-resistant heartwood. The proportion of heartwood to sapwood is greater in larger trees. Douglas-fir in the 10-20-inch diameter size classes have 55-60 percent sapwood which will cull after 2 years of decay. Larger trees in the 40-inch and above size classes have 30 percent or less sapwood.

4. Decay Types

Two common decay fungi are expected to cause the majority of deterioration in the dead timber. These are *Fomitopsis (Fomes) pinicola*, which causes a brown cubical rot of sapwood and heartwood, and *Polyporus abietinus*, which causes a white pocket rot in sapwood. Less impact is expected to be caused by other decay fungi.

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